MAGNETICS AND SUPERCONDUCTIVITY

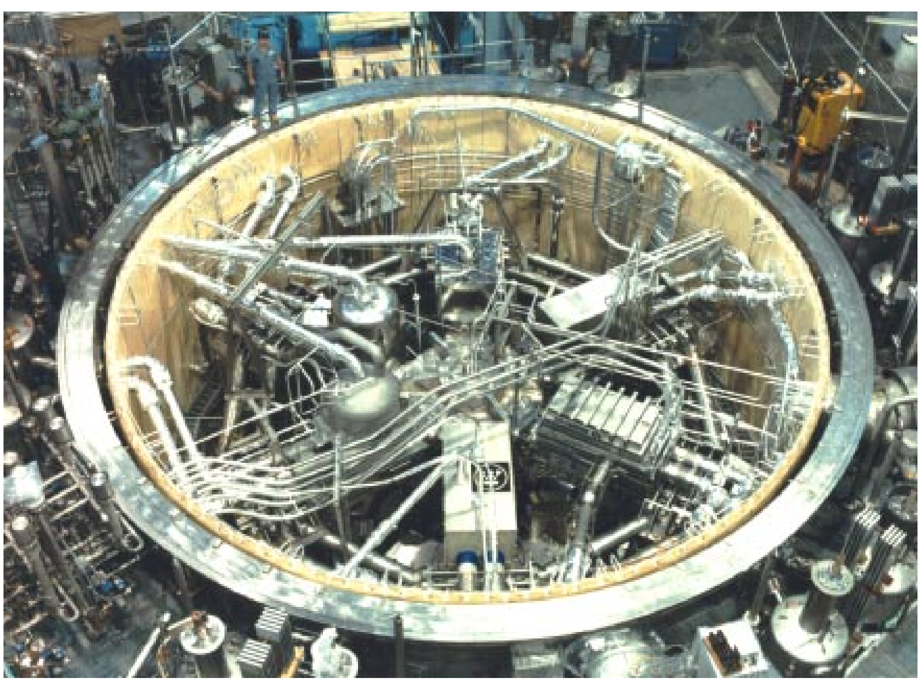
THE BIG CHILL

The magnetic fields needed to confine a fusion plasma are about 200,000 times more powerful than the magnetic field at the earth's surface. Progress in magnetic confinement fusion has been built on magnet research and development, much of which has been carried out in collaborative programs with industry.

Superconductivity—the property of some materials that allows them to carry electrical currents with virtually no resistance—is essential to the economical generation of fusion power. Superconducting magnets on a scale comparable to that needed for a fusion reactor were first demonstrated in an international collaboration between the fusion research community and industry. Industry is now applying the experience gained from this collaboration to design high-field magnets for future fusion experiments. Expertise with low-temperature superconductors, which operate at temperatures near absolute zero, is contributing to the development of a new class of materials that are superconducting at much higher temperatures. The national laboratories and industry are working together on practical applications in areas other than fusion, such as energy storage and conservation, aerospace, manufacturing, health and medicine, and transportation.

Materials that remain supercon ducting in the presence of strong magnetic fields were discovered in the early 1960s. By the early 1970s, fusion reactors with superconducting magnets, or coils, were being proposed.

Development work led to the Large Coil Task (LCT), a program that involved technology transfer and industrial partnerships on an international scale. Six large coils, each weighing about 45 tons, were placed in the International Fusion Superconducting Magnet Test Facility (shown below) and tested to 9 tesla by an international team of researchers. These coils were designed, developed, and manu factured by three companies in the United States and by one each in the European Community, Japan, and Switzerland. By demonstrating the integration of large-scale, advanced technology components that were cooperatively designed and produced by a team of industrial partners, the LCT paved the way for further collaborations and technology transfer on a broad scale.



Companies such as General Dynamics and Westinghouse, which developed their magnet manufac turing capabilities in support of fusion projects such as the LCT, the ELMO Bumpy Torus, and the Mirror Fusion Test Facility, are supplying magnets for the Super conducting Super Collider, a high-energy physics experiment, and developing the 13-tesla supercon ducting coils for the International Thermonuclear Experimental Reactor (ITER).

The materials used to date in fusion magnets are superconducting only at temperatures near absolute zero. In 1986, a new class of materials that are superconducting at much higher temperatures was dis covered. To accelerate the development of these high-temperature superconducting (HTSC) materials, the Department of Energy established High-Temperature Superconductivity Pilot Centers at Argonne National